

## Claims

To be secured by United States Letters Patent, what is claimed is:

1. A method of recognizing objects under various lighting conditions comprising the steps of:
  - (a) providing a database comprising a plurality of three dimensional models;
  - (b) providing an input image;
  - (c) positioning each three dimensional model relative to the input image;
  - (d) determining, for each three dimensional model, an optimal rendered image which is most similar to the input image, said determining step comprising:
    - (i) deriving a reflectance function that describes an approximation of the set of all possible rendered images that each three dimensional model can produce under all possible lighting conditions, wherein said reflectance function analytically

excludes illumination within cast shadows  
on said model; and

(ii) optimizing the reflectance function to  
determine an optimal rendered image of  
each model that is most similar to the  
input image;

(e) computing a measure of similarity between the  
input image and each optimal rendered image;  
and

(f) selecting the three dimensional model  
corresponding to the optimal rendered image  
whose measure of similarity is most similar to  
the input image.

2. The method according to Claim 1 wherein the  
reflectance function includes a local horizon for  
each point on each said model, wherein no light  
originating below said local horizon contributes to  
the reflectance from said point.
3. The method according to Claim 2 wherein said local  
horizon is defined by the polar angle of said local  
horizon in any direction.

4. The method according to Claim 2 wherein said local horizon is variable with the azimuth at each point on said model.
5. A method of deriving a reflectance function of an object model under a variety of lighting conditions, the object model comprising a plurality of surfaces, each of the surfaces defining a normal vector pointing perpendicularly outward, the method comprising the steps of:
- (a) determining a local horizon for each point on said object model, wherein no light originating from below said local horizon is incident at said point;
  - (b) rendering, for a given orientation of the object model, a plurality of images produced by the object model when illuminated by each of a plurality of spherical harmonic components of incident light, wherein said rendering comprises:
    - (i) calculating the intensity of incident light components upon the object model, relative to the normal at each surface,

excluding light originating from below a  
local horizon at any point on said model;  
and

(ii) calculating the intensity of light  
components reflected by the model toward  
the observer; and

(c) defining a reflectance function for the object  
as a linear combination of said plurality of  
images.

6. The method according to claim 5, wherein said plurality of images comprises the images produced by the 0<sup>th</sup>, 1<sup>st</sup>, and 2<sup>nd</sup> order spherical harmonic components of incident light.
7. The method according to claim 5, wherein the step of determining the local horizon for each point on said object model comprises determining the local horizon as a function of the polar angle of the local horizon at each said point.
8. The method according to claim 7, wherein the function measured by the polar angle is dependent on the azimuth.